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Parametric studies in elastic stability of nonconservative beams

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Abstract

In this paper the nonconservative Beck`s column loaded with follower compressive force is generalized by introduction of the possibility to be subjected to subtangential follower force with excentric point of action. For corresponding boundary eigenvalue problem the frequency equation is derived. Results of parametric studies are presented for the lowest eigencurves, which describe the relation between the compressive load magnitude and the eigenfrequencies and indicate whether stability loss by divergence or by flutter occurs.

Keywords: elastic stability, generalized Beck-Reut`s column, divergence, flutter

1. Introduction

The Beck`s column is a classical example of relatively simple nonconservative system. The cantilever loaded by a compressive force **P** of constant magnitude gives rise to different types of behaviour in dependence of the way the load interacts with the beam structure. The most common case is given by the "dead" load, see fig. 1a, when the direction of the compressive force maintains its orientation whatever the beam deflections are. Gravitational forces are typical example, the corresponding boundary problem is selfadjoint and as far as the elastic stability is concerned, the Euler`s classical approach gives satisfactory results. In other words, the statical criterion of stability can be used. Beck`s column is a cantilever loaded by a compressive force oriented in direction tangential to the deflection curve, fig. 1b. This type of load is labeled as follower force. One of few true possibilities to realize such follower force is the application of a reactive force at the free end of the cantilever. Beck`s column is a nonconservative system. To asses its stability the dynamic criterion of stability is required in which inertia effects are included. The loss of stability in the case of conservative dead load corresponds to divergence, while under the follower force the mechanism of stability loss may correspond to flutter – i.e., vibration with increasing amplitude. Attractive feature of the Beck`s column is the fact, that theoretical critical compressive force is more than eight times higher than the critical force at the conservative case.

Reut`s column arises when the compressive force maintains both the direction and the line of action, fig. 1c. Obviously a platform at the beam tip is required to keep its interaction with the deflecting beam. Here due to excentricity ε additional moment acts at the beam end. This case is also nonconservative, moreover, in mathematical terms the Reut`s column is adjoint of the Beck`s column and as such has the same critical loads as the Beck`s column. Generalization of the above mentioned three beams we obtain if we admit subtangential compressive force together with partial excentricity as illustrated in fig. 1d. The aim of this

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